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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Lubrication of Compressed Air Machinery

PUBLISHED MONTHLY BY
THE TEXAS COMPANY
TEXACO PETROLEUM PRODUCTS

TEXACO LUBRICANTS

For Air Compressor Cylinder Lubrication

Low Pressures or Temperatures	TEXACO CETUS OIL, OR TEXACO CANOPUS OIL
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High Pressures or Temperatures	TEXACO ALGOL OIL, OR TEXACO URSA OIL
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Blowing Engines	TEXACO PELICAN OIL

Recommendations as above can at best be only approximate. It must be remembered that pressures, temperatures, clearances and rubbing speeds, or various combinations of these may differ widely, thereby causing conditions that can only be met by individual consideration and the use of a special lubricant.

For example, in many cases

TEXACO REGAL OILS

have proven the most satisfactory products to use.

Therefore it is advisable to always avail yourself of Texaco Lubricating Engineering Service, where data is available on all types of Air Compressors and operating conditions.

NOTE: For Texaco Lubricants for external bearings and steam cylinders, see recommendations for Steam Engines, Pumps and Compressors in LUBRICATION, August, 1927.

THE TEXAS COMPANY

Texaco Petroleum Products

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Lubrication of Compressed Air Machinery

THE extent to which compressed air is used in industry today requires an intimate knowledge of air compressing and manipulating equipment, viz.:

The means of obtaining and
The means of utilization.

Compressed air is the salient factor in the accomplishment of mass construction. Without it, as an adjunct to the operation of the pneumatic tool, building construction, the digging of tunnels and the carrying out of mining operations as required today, would be virtually impossible.

Even the petroleum industry has felt the need for resorting to the compressor for the development of the requisite pressure for operation of gas or air lift wells. There is a coincidence here, for whereas the air compressor and pneumatic tool are absolutely dependent upon petroleum lubricants for continued and economical operation, in turn the production of crude petroleum to meet our ever-increasing demands, is coming to be decidedly dependent upon the air compressor, as an aid to oil flow and for the operation of drilling tools.

Practically speaking, compressed air and lubrication are certainly on a par with steam and electric power, as factors in the maintenance of present-day civilization. Each is dependent upon the other, to a more or less extent, contingent, of course, upon the equipment involved, and the nature of the work. All means of power development or utilization, however, will hinge upon lubrication and the degree to which metallic friction and wear are reduced by means of suitable lubricating oils or greases.

CHARACTERISTICS OF EQUIPMENT INVOLVED

The air compressor is the salient equipment involved in the development of compressed air, just as the pneumatic tool is the all-important device for its subsequent utilization.

Work, of course, must be done in the compression of air; as a consequence heat is developed, temperatures rising as the pressures are increased.

The evolution of heat by the expenditure of work is a natural physical phenomena. Machine operation in general will bring about this occurrence to a more or less extent, depending upon the friction involved. Normally, however, such heat will have an opportunity to dissipate itself in some manner or other, either by radiation or conduction.

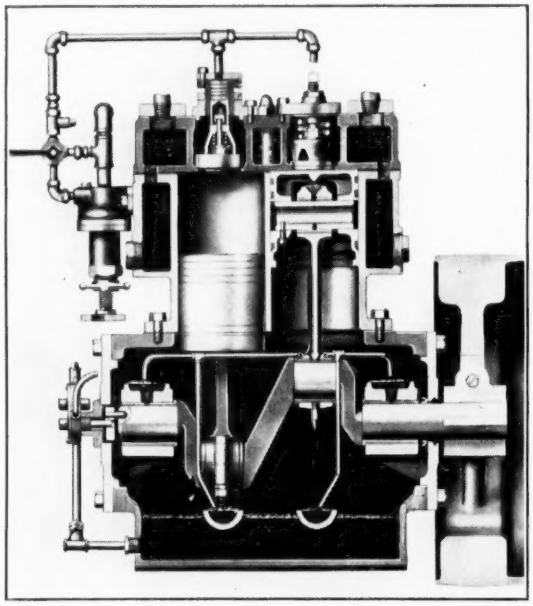
In the air compressor, the heat developed is not a result of friction; it is, rather, the consequence of the work done on the air during the compression stroke. Air compressor lubricants must, therefore, be capable of standing fairly high temperatures.

With pneumatic tools, however, an opposite condition is involved. In other words, comparatively low temperatures must be dealt with, because air, in its expansion and passage through tool mechanisms, absorbs heat from its surroundings unless it has been preheated.

As a result, unless atmospheric temperatures are relatively high, the expansion temperature may run quite low. In general, therefore, pneumatic tool lubricants must be able to withstand low temperatures.

TYPES OF COMPRESSORS

In order to more fully appreciate the subsequent remarks regarding lubrication, the basic constructional features of the several types of



Courtesy of Chicago Pneumatic Tool Co.

Fig. 1—Sectional view of a vertical water-cooled air compressor. Both splash and force-feed lubrication are employed to serve the bearings and cylinders. Note oil level, splash pans and circulating piping.

air compressors on the market today must be understood. In general, there will be:

1. Single stage reciprocating compressors.
2. Multi-stage or compound reciprocating compressors.
3. Rotary compressors.
4. Blowers of the centrifugal or rotary type.
5. Blowing engines.

Single Stage Machines

Single stage compressors or compressors subjecting air to but one compression, are built generally of the one-cylinder, single acting variety. The piston in these machines is usually of the trunk type, the upper section carrying one or more rings which seal the cylinder and prevent excess oil from being drawn in or splashed, where they are designed for splash lubrication. The lower portion of the piston usually carries one ring only. Vertical single-stage compressors are built in various sizes from one cubic foot capacity upward. Horizontal single-stage compressors are of the one-cylinder double-acting type.

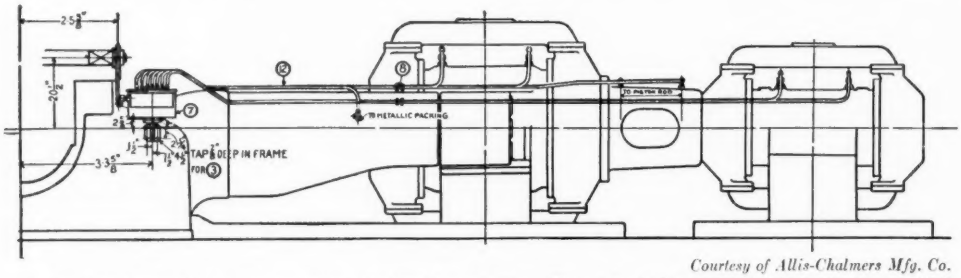
Multi-Stage Compressors

Multi-stage reciprocating compressors wherein air is subjected to two or more compressions, are used when pressures in excess of 80 pounds are desired. In compressors of this type the air receives an initial compression in one cylinder. Passing through an intercooler which serves to reduce the temperature, it is then compressed in a second cylinder and so on in succession until the desired compression pressure is attained.

Because of the more effective cooling and because clearance losses are reduced, multi-stage compressors are more efficient. Theoretically, therefore, the more stages the higher the efficiency, but size and cost of machinery, as well as frictional losses, limit the number of stages to seven at the most. In such machines, pressures of from 1000 to 15000 pounds are attainable.

Rotary Machines

Rotary compressors differ widely in design, but as a rule they use either sliding vanes rotating in an eccentric housing or rotating gears or cams so arranged as to alternately increase and decrease the enclosed air space. This type has not attained such general application as the piston type, both because of the complexity of the moving parts and inability, as a



Courtesy of Allis-Chalmers Mfg. Co.

Fig. 2—Line sketch of the oiling system on a horizontal compressor. The mechanical force feed lubricator is shown at "7," oil piping is indicated by heavy black lines.

both single and double acting and may be either horizontal or vertical. They are used for the compression of air up to approximately 80 pounds. Vertical single-stage compressors are

general rule, to produce large volumes and high pressures as easily as the piston compressor. In certain specific cases, however, the rotary compressor is quite efficient and the opportunity for

future development is great; in addition its lubrication requirements are less exacting.

Blowers

Blowers may be either of the centrifugal or rotary type, they are built to supply large quantities of air at low pressures. The centrifugal fan blower consists of a more or less scientifically designed "paddle-wheel," revolving in an eccentric casing. Such machines operate at pressures below one pound and are much used in heating and ventilating. Blowers of the bucket type develop along with the centrifugal action, a certain pressure due to the shape of the bucket or blade. They may often impart a velocity to the air in excess of the peripheral speed of the rotor. In any centrifugal machine, no lubrication of the air side is involved.

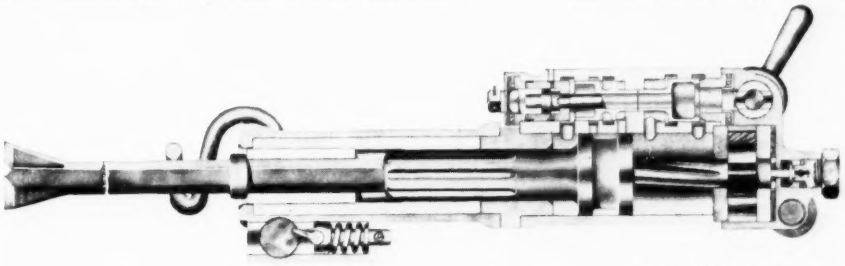
Blowing engines are very large, slow moving, reciprocating compressors, which are employed principally in iron and steel plants for supplying large quantities of comparatively low pressure air to the blast furnaces. Blowing engines may be either horizontal or vertical in construction; as a rule, they present no unusual lubricating difficulties.

PURPOSE OF PNEUMATIC TOOLS

As the name implies, a pneumatic tool is a mechanical device usually portable in nature, self contained in regard to its propelling and operating mechanisms, and functioning by the energy resulting from the expansion of compressed air.

The basic purpose of the pneumatic tool is to supplant the tedious and more or less unsatisfactory methods of manual labor with the far more rapid and efficient methods of automatic production.

These desired results are attained either by the effects of percussion or rapid hammering at the rate of often several thousand strokes per minute, or constant pressure, or, in some cases, a combination of pressure and rotation.



Courtesy of Gardner-Denver Co.

Fig. 3—Sectional view of a rock drill showing essential working parts in relative position.

Where percussion is employed, as in the case of certain types of rivet, caulking and chipping hammers, etc., air pressure acts on the tool mechanism in much the same manner as steam acts on the pistons of a steam engine. In other words, the tool mechanism involves one or more cylinders with suitable companion pistons, and either an arrangement of valves for the admission of air at the proper time or percussive frequency required; or, as in the valveless type, a piston which acts as its own valve.

Just as in the reciprocating steam or internal combustion engine, where valves are required, there will usually be two sets involved; i.e.

(a) Valves which by virtue of their timing, control the frequency with which the air pressure is allowed to react on the piston; and

(b) The throttle valve whereby the operator controls the amount of air admitted to the tool.

We are, therefore, confronted with more or less the same conditions of wear as in the reciprocating engine.

DESIGN AND CONSTRUCTION

To lead to a better understanding of the necessity for careful and proper lubrication, it will be of decided interest to discuss some of the more extensively used types of pneumatic tools from the viewpoint of their principles of operation and details of construction.

Drills

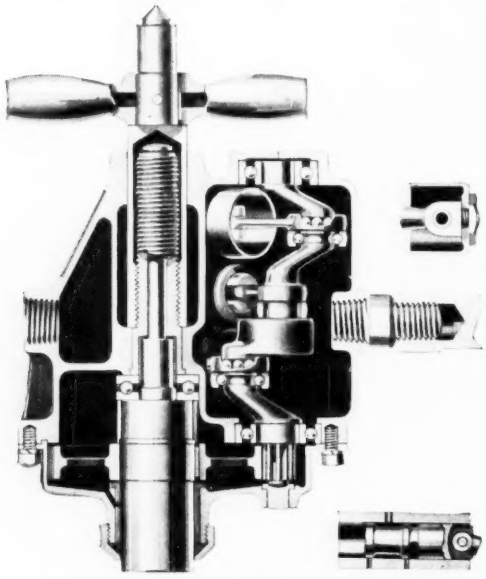
Of the rotary type of pneumatic tools, the drill is, perhaps, the foremost in usage and importance. Adaptable to wood, metal and stone working, according to the nature of its cutting tool, it is a very valuable piece of equipment in industry.

As generally constructed, a rotary air drill will comprise a number of suitable cylinders with their respective pistons; the requisite crankshaft and connections for transformation of reciprocating motion into rotary motion; a train of gears for bringing about speed changes, and the requisite gear and crankcase. Many of such drills are of the balanced piston type with four single-acting pistons, opposed or connected in pairs to opposite wrist pins of a double crankshaft.

Riveters

Riveting tools are essentially of two types, dependent upon whether they perform their function by percussion or the striking of blows in forming the rivet head, or by pressure in a similar manner to the metal press. It is of interest to note that the former involves an application of the principle of swaging, the

metal being caused to literally flow into the proper shape of the rivet head under the effect of the rapid percussion of the tool. Where constant pressure alone is involved, in certain tools, rolling action is also employed, especially for small rivets, by the action of a set of rollers functioning under pressure.



Courtesy of The Cleveland Pneumatic Tool Co.

Fig. 4—Interior view of an air motor. Crank bearings, ball bearing connecting rods, pistons, gears and pinions, etc., can be effectively lubricated by grease injected into the case by means of a pressure gun.

Pneumatic Hammers

In the case of hammers, however, percussion or the rapid striking of blows is the essential action involved. The self-contained forge hammer is an interesting example wherein the air-operated ram is alternately raised by the dual means of compressed air pressure below, plus a partial vacuum above, and forced down by a reversal of these means of operation.

Pneumatic Hoists

The power hoist which employs compressed air as the operating media is another interesting machine pertinent to this discussion. Pneumatic hoists may be either of the direct lift or geared type, dependent upon whether air pressure acts directly upon the piston, or operates an air motor, which, in turn, drives a hoisting drum by means of worm or spur reduction gears.

Pneumatic hoists are chiefly used for short lifts in such localities as machine shops, forges, foundries, etc., where compressed air is available. The direct acting hoist may be either single or double acting, according to the construction and provision for air inlet. The single acting hoist is essentially a vertically operating device, air being admitted below the piston to raise it, as desired.

The double acting hoist, on the other hand, may be used in either horizontal or vertical position. In this type of hoist the power end of the cylinder is under a constant pressure of air; the opposite or balancing end is likewise under pressure, but this latter is capable of variation, according to the load carried or duty required. In this case pressure can be varied from no load to full or balanced load.

Essential Requirements of Air Compressor Oils

An air compressor oil must possess certain very definite properties if it is to function effectively and without undue possibility of developing into a hazard by virtue of subsequent decomposition when exposed to heated air. Broadly speaking, the essential characteristics which will indicate the ability of the oil to meet requirements are:

(a) The viscosity.
(b) The flash and fire points, and
(c) The tendency to form carbon deposits.

Relation of Viscosity

In air compressor lubrication, the viscosity of the oil is a far more important characteristic than many will imagine. Upon the viscosity will depend the piston seal that will be obtained, and consequently the efficiency of compression.

If the oil is too light in body, i.e., low in viscosity, at the operating temperatures in the cylinder, it may work past the piston rings to impair the seal.

While an air compressor oil should, therefore, have a viscosity high enough to sustain the weight of the moving parts, and form a proper seal between the piston rings and the cylinder walls, it should never be so heavy as to cause reduction in atomization or involve excessive internal friction.

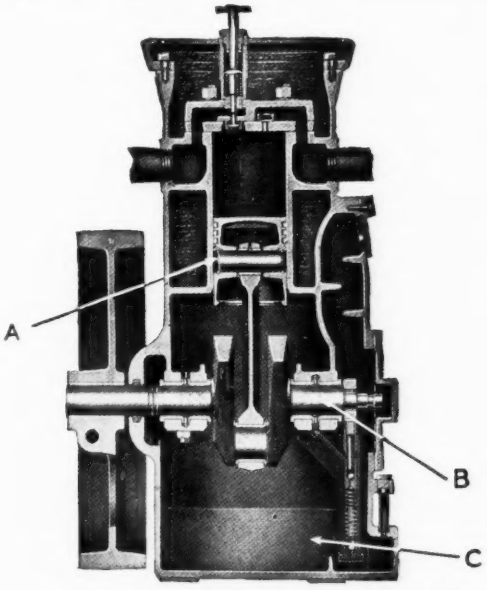
Moreover, if too heavy an oil is used, it will more easily collect any dust that may be present in the air and will tend to bake on the hot surfaces and form carbon deposits. This is especially likely to happen when more oil has been used than just sufficient to lubricate the wearing surfaces, or where an air cleaner is not used.

Flash and Fire Points

High flash and fire points have been decidedly over-emphasized in their relative importance as qualifications for air compressor lubricants. In fact, observation of the conditions under which explosions will tend to occur has developed that the possibility of formation of deposits within the compressor or air lines requires far more consideration.

In any installation, where such deposits are present and are rendered incandescent for any reason whatsoever, an explosion may occur irrespective of the flash or fire points of the lubricating oil. Otherwise the oil would have to be submitted to a temperature much higher than its laboratory flash point before combustion could take place.

As this temperature would be in the neighborhood of 1100 degrees F., the operator can readily appreciate that it is unwarranted to worry as to the possibility of certain compressor oils being the more explosive, simply because their flash point is below the temperature of the discharged air, provided that carbon deposits and leaky air (discharge) valves are guarded against.

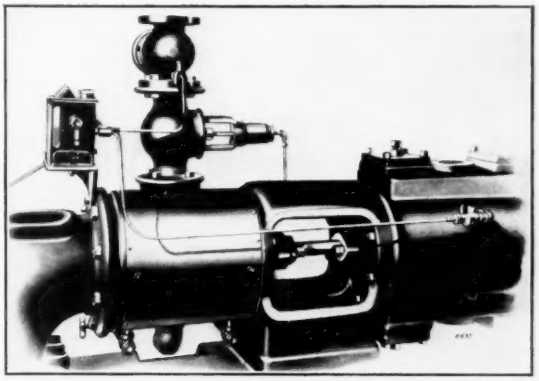


Courtesy of Worthington Pump & Mach. Corp.

Fig. 5—Cut-away view of a vertical feather valve compressor. A feature is the force feed oiling system. Oil is circulated from reservoir "C" via a plunger type pump at the right through drilled holes in the crankshaft, "B" to the compressor bearings. "A" indicates piston with two oil grooves and free floating wrist pin. Surplus oil is scraped off the cylinder walls by special piston and ring construction.

Furthermore, cylinder walls are generally cooled by water-jacketing and hence the temperature of the oil layer next to the wall is practically little above that of the wall itself. The oil layer exposed to the heated air, however, becomes much hotter than the rest of the oil body and a portion of it may be vaporized. As oils are composite mixtures, different portions will be distilled or vaporized at different temperatures.

Certain of the lighter products may pass off even at temperatures below the flash point, leaving the heavy ends dissolved in the oil next to the wall. The final result, especially where



Courtesy of Ingersoll-Rand Co.

Fig. 6—Showing location of a force feed lubricator on a horizontal compressor. Here the one lubricator is designed to serve both the air and steam cylinders via suitable pipe connections as shown. Inasmuch as two distinct types of oil must be used, the lubricator is built with separate compartments.

an excess of high carbon content oil is used, may be oxidation and the building up of a gummy mass which has a low vapor pressure and high distillation point.

Carbon Deposits

Deposits of carbon plus dirt on the valves or in the discharge lines of an air compressor are to a certain extent caused by such decomposition of the oil.

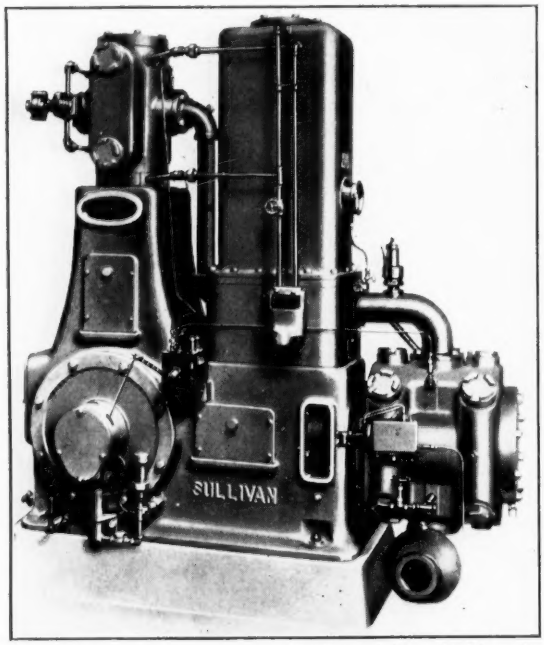
It is an accepted fact that mineral lubricating oils, regardless of their base or nature, will decompose to volatile products and carbon when subjected to hot air under pressure. The extent of this decomposition of course depends on the length of time the oil is exposed to such heat. Naturally, also it will follow that the oil which remains in the compressor cylinder or on the discharge valves the longest will form the greatest amount of carbon.

On the other hand, analysis of numerous so-called carbon deposits has proven them to consist more of dirt than of carbon, the whole being held together by gummy matter from decomposed oil.

For this reason an oil having a wide range of distillation, high end point, or too great a viscosity is objectionable, inasmuch as, instead of vaporizing cleanly, it breaks down as has been mentioned above, becoming sticky and collecting dirt brought in by the air. The slower the breaking down process, or the greater the volume of oil involved, the more carbon will ultimately be developed.

Nature of Such Deposits

True carbon may be formed in cylinders in a hard mass or it may be produced in the shape of dust and pass out with the air. In the latter case, it will often collect in pockets, elbows or



Courtesy of Sullivan Machinery Co.

Fig. 7—Showing the manner of locating a Madison-Kipp mechanical force feed (air cylinder) lubricator on an angle compound compressor. Note lubricator just above horizontal inspection plate, with driving connections to crankshaft, and piping to both vertical and horizontal cylinders.

on sharp edges and become mixed with dirt taken in by the air as well as with oil which has been vaporized in the cylinder, and later condensed at these points.

If deposited in the cylinder, carbon, being a poor conductor, may become heated considerably above the temperature of the cylinder walls. Not only may this be hazardous, but also, hard carbon especially, is always a nuisance, due to the possibility of accumulation on the valves and valve seats, and in the ends of the cylinders. This may cause valves to leak, frequently resulting also in cutting of the latter and scoring of the cylinders.

Instances are known of where carbon deposits have collected in the valve passages and bends of piping to such an extent as to restrict the opening through which the compressed air had to pass. When once started, such formations continue to build up, so narrowing the passage that pressures may be produced capable of eventually causing an explosion.

Pale filtered distilled oils, properly refined, are very free from both direct carbonization and the collection of carbonaceous matter. Furthermore, any such direct carbon that may be formed through excessive use, is of a light, fluffy nature. Carbon deposits formed from improperly refined or unsuitable oils, on the other hand, are often of a hard flinty nature. Any oil, however, will accumulate dust if the air is dirty.

METHODS OF AIR CYLINDER LUBRICATION

It is not only important, however, to select lubricating oils for air compressor cylinders which will have the proper viscosity, flash point and low carbon content. The method of application will also be a decided factor in the subsequent attainment of effective lubrication.

In fact, it is safe to say that granting the oil selected for air cylinder lubrication satisfies the requirements discussed heretofore, the possibility of future difficulties due to carbon formation will depend upon the method of feeding the oil and the quantity supplied.

Many authorities feel that this entire matter of efficient air compressor cylinder lubrication hinges upon the amount of oil used. Any excess supplied over that actually required will mean either:

(a) That this will be consumed by vaporization and breaking down in the compressor with the formation of a certain amount of direct carbon, or

(b) That it will be carried over with the air to subsequently collect in the intercooler or in pockets elsewhere in the system.

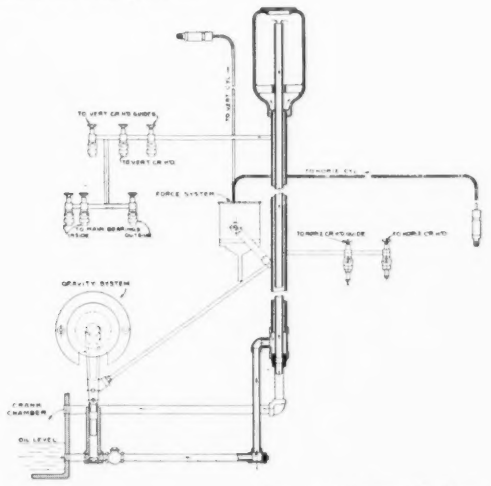
Point of Delivery

Air compressor oil will function best when it is completely atomized prior to being delivered to the cylinder. To effect such atomization in small and medium-sized compressors, the oil is often introduced at or above the point of air intake, the inrush of air carrying the atomized particles or spray of oil to all parts requiring lubrication. On account of the small amount of oil involved, and the fact that a filtered oil is more readily atomized, the lubricator can in such cases be located fairly near the intake as atomization is effected in a relatively short distance of travel.

Air does not carry oil particles as readily as does steam. Horizontal compressors, therefore, may not receive sufficient oil at the uppermost parts of the piston and cylinder to insure satisfactory lubrication unless the oil feed is perhaps increased above the usual theoretical requirements. This is inadvisable, since the bottom parts of the cylinder, being probably over-lubricated, will lead to the collection of oil in pockets, with ultimate carbonization.

In such cases, the procedure is to feed the oil directly to the sliding surfaces by means of sight feed drip oilers or force feed lubricators. This,

in fact, is customary practice on all large installations. Oil introduced in this manner is distributed to the cylinder walls by the wiping action of the piston.



Courtesy of Sullivan Machinery Co.

Fig. 8—Details of the complete oiling system of an angle compound compressor. Crankshaft bearings, crank pins, crosshead shoes and pins are automatically supplied by oil contained in the bottom of the frame at a level as shown, and distributed by means of a small plunger pump attached to the frame. Note that cylinders are separately served by a mechanical force feed oiler.

The Force Feed Lubricator

Automatic pressure lubrication by means of a force feed lubricator whereby the flow of oil to the cylinder can be regulated, is perhaps the most efficient and economical method available.

By use of this device the possibility of overfeeding oil to any particular part is reduced, oil flow stops and starts with the compressor, and the requisite lubricating and sealing film is more nearly assured.

Force feed lubricators are not affected by variations in air pressure, and they will feed the oil continually in accordance with their adjustments and the speed of the compressor.

Type of Compressor Must Be Considered

Of course, different types of compressors will naturally involve certain variations in their lubrication; in fact, they may even require radical departure from what are normally classed as standard methods in this regard. In general, however, the force feed lubricator, an arrangement for pressure circulation, or adaptation of the principles of splash lubrication must be used; the application, etc., being planned according to the recommendations of the compressor builder, based on the design of the machine, its size, capacity, and the character of the valves employed.

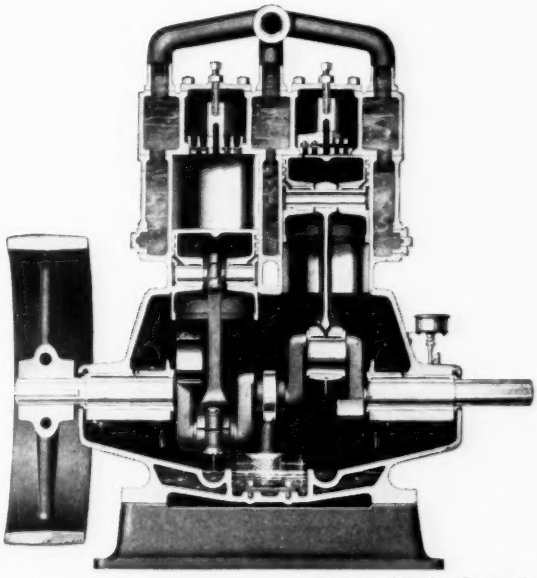
Certain of the latter, such as flap and plate valves ordinarily require no lubrication. Others, such as grid, Corliss and poppet valves require either direct application of oil, or will receive the requisite lubrication from the oil particles which are carried by the air.

The operator or engineer is, therefore, urged to consult with the builder of his machine either when planning on lubricator installations, etc., or when he feels his lubrication is faulty. As often as not, the oil is perfectly adapted to his machine requirements, the trouble being with the method of application.

Over-Lubrication a Detriment

It is inadvisable to establish any hard and fast rule in regard to the theoretically proper amount of oil that should be supplied to an air compressor cylinder. There are too many variables involved, such as the size of the compressor, its speed, and the condition of the piston and piston walls. The important point in any event is to guard against over-lubrication, inasmuch as more trouble will be caused by the use of too much rather than too little oil.

It must be remembered that oil will probably remain in an air compressor cylinder considerably longer than in the cylinders of either a steam or internal combustion engine, owing to the fact that there is little or no washing action or dilution of the oil film involved. As a consequence, very much less oil will be required per unit of cylinder surface over the same time interval.



Courtesy of Gardner-Denver Co.

Fig. 9—Cut-away view of a direct connected motor driven air compressor showing oiling system. Note oil level in base with splash troughs below connecting rod bearings.

It is a safe rule to use just enough oil to prevent frictional wear and to permit easy and free operation of all parts; more than this will lead to trouble.

Effects of Unsuitable Oils

If the lubricant is unsuitable, an excessive amount will be required to keep the pistons from groaning in the cylinders; in addition, the result of using an excessive amount of oil will be carbonization in the air passages, and particularly on the discharge valves. Sticking of these valves, with the passage of hot compressed air back into the compressor cylinder, is generally indication of over-lubrication. The discharge valves should therefore be examined regularly, and the aftercooler, receiver, or discharge pipes periodically blown out.

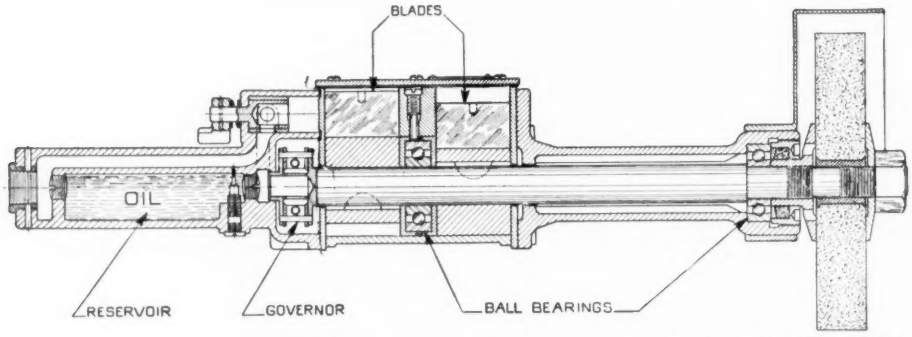
This will effectively remove any oil, water or sediment, which may have accumulated. If upon removal, the discharge valves have a greasy appearance, enough oil is being fed to the cylinders; on the other hand, if the parts appear very oily or little pools of oil are found in compressor pockets, or in any of the air lines, oil is being fed in excess of that required, or has been improperly distributed.

Amount of Oil Required

There is a general rule to the effect that air compressors are sufficiently lubricated if one or two drops of the proper grade of oil are used for each 500 or 600 square feet of cylinder surface swept by the piston per minute. This rule, on the other hand, must be governed by the condition of the cylinders and the temperature and degree of compression.

The number of drops of oil which can be secured from a certain amount of any grade of oil will vary with the viscosity, temperature, service conditions involved and the diameter and shape of the lubricator orifice. As a result, the number of drops secured per minute from an oil having a Saybolt viscosity of 200 seconds at 100 degrees F. would differ from the number secured from an oil of 300 seconds viscosity. Also the type or design of the lubricator, i.e., whether mechanical, force feed or hydrostatic, would affect the number of drops obtained.

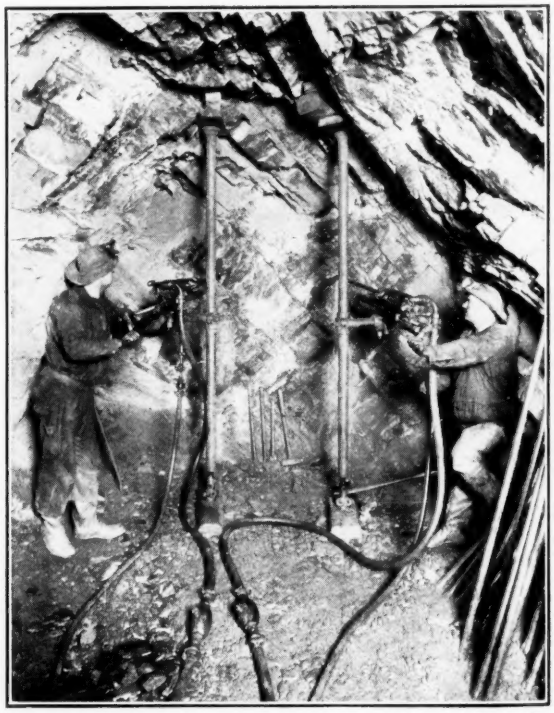
It is therefore not considered good practice to make an absolute recommendation as to the number of drops per minute that should be used in air cylinders of various sizes on account of the great variation in operating conditions that will be met with.



Courtesy of The Rotor Air Tool Co.

Fig. 10—Sectional view of a grinder showing the oil reservoir, governor and ball bearings. Oil enters the motor along with the incoming air being regulated by an adjustable needle valve. This oil not only lubricates the bearings, but also forms a seal within the clearance between the rotor and cylinder walls to prevent leakage of air.

In fact, two compressors of the same design, same size, and built by the same manufacturer, may be operating in a room under identical conditions, yet it will be practically impossible to secure the same fit of piston rings and valves and the same polished cylinder surfaces. Experience has shown that two such com-



Courtesy of Gardner-Denver Co.

Fig. 11—Installation view of two "Waugh" line oilers on drifting drills in an iron mine. By use of such equipment the requisite amount of oil is automatically injected into the air as it passes to the tool.

pressors may require a surprisingly different amount of oil for air cylinder lubrication.

In addition, the varying temperatures of the room will affect the feed of the lubricator, and while the operator may adjust the latter to give the same number of drops at different temperatures, with certain types of lubricators the difference in the size of the drops, and hence in the amount of oil fed to the cylinder will be quite appreciable.

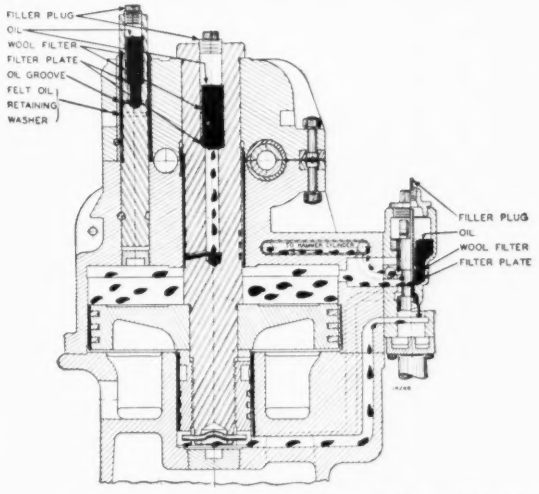
Air Tool Lubrication

Proper lubrication of pneumatic tools can well be prefaced by reference to operating conditions. As a general rule such equipment is very often subjected to decidedly severe service, frequently being thrown around or dropped regardless of whether it may land in mud, slush, water or on rock, concrete, etc.

Handling in this manner will be found to result in more or less ultimate damage to the working mechanisms, even if the casing is rugged enough to come through whole. Furthermore, a certain amount of dust, dirt and water may frequently gain entry to damage, score or abrade the wearing elements when coming in contact with same.

Lubrication Under Water Conditions

It is relatively difficult for many lubricants to withstand such water conditions, however suited they may otherwise be to the actual operating requirements; for water will tend to wash off the lubricating film from wearing surfaces.



Courtesy of Ingersoll-Rand Co.

Fig. 12—Sectional view showing the lubricating system of a drill sharpener. The passages of the oil from the respective wells to the various parts of the sharpener are shown in heavy black outline. Note that wool filters are installed in each oil well to insure against possible passage of abrasive foreign matter to the wearing parts.

It is for this reason that compounded lubricants, i.e., mineral oils containing more or less animal oil or soap in compound are recommended for the lubrication of equipment such as hammer drills where operating with water. Such lubricants function on the same principle as do steam cylinder oils. In other words, they have more tendency to adhere to metal in the presence of water than do straight mineral oils.

But such lubricants are only recommended for air tools wherein water is intentionally mixed with the air to serve the purpose of washing cuttings from the hole, in much the same manner as a soluble oil solution washes metal cuttings away from the tool in the machine shop drill, etc.

Where pneumatic tools are designed to function dry, they should be absolutely dry—that is, free from moisture as far as possible; for on such equipment straight mineral lubricants are generally used. These, if properly refined and of the requisite viscosity and pour test, will adequately withstand the slight washing effect that may occur from condensation of moisture from compressed air as normally used. They will not, however, protect the wearing surfaces against an excess of moisture as may occur if the tool is dropped in the mud or allowed to remain exposed to the elements for any length of time while not in use.

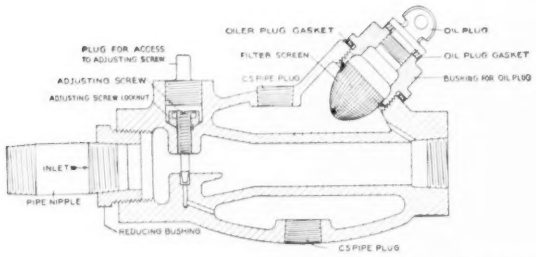
The ultimate result will, of course, be rusting and corrosion, with subsequent difficulty in operation, an inability to perform its rated amount of work, and the necessity for repair or replacement of parts.

In the wet type of tools, such as hammer drills, water leakage must also be guarded against. As a result, conditions in the cylinders are somewhat similar to those encountered in the cylinders of pumps. In the case of mine drills this water may also frequently contain an appreciable percentage of acid, leading to the added possibility of corrosion.

Abrasive Materials a Detriment

Abrasives such as dust and dirt which may gain entry in much the same manner, through careless handling, not to speak of the dirt which may be carried through the tool by the air itself, will in turn be detrimental and cause abnormal wear as stated.

It is relatively easier to protect a tool from the entry of abrasive foreign matter via the tool itself than via the airline. Rarely will any appreciable amount of dirt penetrate the tip orifice while air is passing through it. All that is usually necessary is, therefore, care in handling when not in actual operation. So if when inactive it is stored or rested in a position or locality free from dirt, it should function satisfactorily, all other things being equal, for an indefinite period.



Courtesy of Ingersoll-Rand Co.

Fig. 13—Sectional view of an air line oiler showing the details of construction and essential parts.

Clean air, however, is not always possible to obtain. This will all depend upon the location of the compressor, its air intakes, whether or not air filters are installed, and the cleanliness of the air coolers and air lines.

Furthermore, there will also be the possibility of particles of rust being carried along by the air, especially where lubrication has not been adequate in the protection of those parts of the system exposed to moisture. Then too, particles of rubber from the air hose and gaskets may also find their way into the air passages and cylinders along with other foreign matter, to materially interfere with the free operation of the tool.

A wire strainer of suitable fineness located in the inlet pipe will be found to be advantageous in the removing of much of the above foreign matter and the protection of the working mechanisms of the tool.

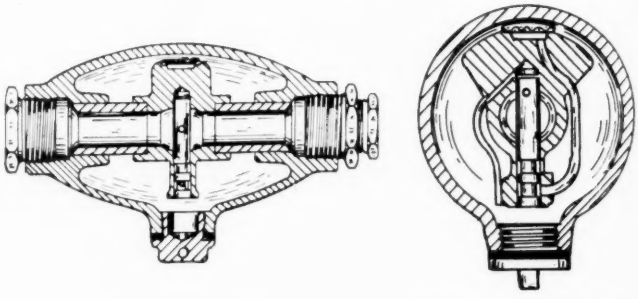
METHOD OF LUBRICATION A FACTOR

To further protect pneumatic tools against the entry of foreign matter, care must also be exercised in regard to the feeding of the lubricants. Where automatic lubrication is provided for by means of pipe line lubricators or atomizers which mechanically deliver the requisite amount of oil to the air lines, there will be the least possible chance of dust or dirt being carried in, provided that the oil is properly stored and handled. Such devices literally lubricate the air, as already mentioned, in much the same manner as mechanical or hydrostatic lubricators will lubricate the steam in a steam engine. Air under pressure, just like steam, will readily carry properly atomized oil to the working elements of the tool, adequately distributing it to all wearing parts.

Where drills, hammers and other such tools must be periodically oiled by hand, however, in the absence of automatic means of lubrication, there may be more possibility of accidental entry of dust or dirt occurring. At best, operators' hands will be dirty, and in such localities as mines, quarries, etc., the atmosphere will often be laden with dust. Of course, under such conditions the lubricants for current usage should be stored and handled with the utmost care. Instances have been noted where these latter were kept in open cans adjacent to the tools, the only apparent idea being handiness and to eliminate loss of time as far as possible when lubricating. Naturally considerable dust and dirt was bound to settle in these containers, with the result that the tools were practically being lubricated with an abrasive compound.

LUBRICATING REQUIREMENTS

To meet these operating conditions, pneumatic tools, according to their design, will require three distinct varieties of lubricants. In this connection mention has been made of the necessity for using compounded lubricants on tools wherein water is employed; also there are those cases where low pour test is essential; and finally we have those heavy, slow moving tools or parts which will function best on grease.



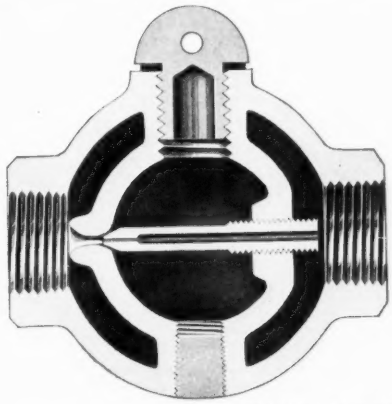
Courtesy of Gardner-Denver Co.

Fig. 14—The "Waugh" line oiler shown in longitudinal and transverse section. Note oil filler opening at top through which fresh oil is added. It is also practicable to adjust the nozzle through this opening so that proper atomization of oil will be assured at all times.

Oils are in general required for valve and cylinder lubrication of higher speed tools, and

in some cases for the lubrication of the chuck parts and impact end of the piston.

Where tools involve gearing the matter of lubrication requires that gears, crankshaft bearings and cylinders must be served. As a rule this can be adequately taken care of by



Courtesy of Chicago Pneumatic Tool Co.

Fig. 15—Sectional view of the "Little Giant" Automatic Oiler. Note the oil chamber in the center, and the needle or pin valve. Air passing through the latter carries the necessary amount of oil into the tool. This is an atomizer type of oiler.

means of two lubricants; one, of the nature of a liquid grease or petrolatum to serve the gears and crankcase bearings, etc.; the other, an oil to serve the cylinders.

In the more modern type of air drill for example, the crankshaft will frequently be equipped with ball bearings, the connecting rod being furnished either with plain or roller bearings. It can be appreciated, therefore, that the crankcase lubricant must be such as to adequately lubricate these varied bearings, with the least amount of internal friction and tendency to separate or to develop free fatty acids. In consequence, greases for this purpose should be selected with the utmost care.

Air cylinder lubrication, in turn, frequently involves the problem of possible low temperatures. In rock drills, especially, will there be possibility of abnormally low temperatures, due not only to the moisture which is usually in the air, but also the fact that narrow, tortuous air passages must generally be traversed in the course of expansion. In such drills it is frequently customary to "lubricate the air" prior to its delivery to the tool, a suitable lubricating device being installed in the air line a short distance back from the throttle valve.

APPLICATION OF PNEUMATIC TOOL LUBRICANTS

While the type and extent of refinement of the lubricants employed have much to do with efficient operation of pneumatic tools, the means whereby the former are admitted or distributed has a marked effect upon their ability to best serve the intended purpose. It is evident that even the best of oils or greases may fail to function effectively if they are haphazardly used, and in such a manner as to be unable to reach all the wearing elements of the tools.

Probably more failures or complaints arise from ineffectual lubrication through misusage of lubricants than from any average operating condition. In many cases this will be due to ignorance; in others, however, sheer neglect is the reason often because of lack of appreciation of the lubricating requirements of their equipment.

There are excellent oils and greases on the market, in most cases refined more or less especially to serve pneumatic tools, with a minimum of fluid friction, a maximum of sealing ability in the prevention of air blow-by past the piston, and of a pour test commensurate with the operating requirements as already mentioned.

It is therefore up to the operator to select and use these products intelligently, in accordance with the recommendations of the builders of his tools, and the oil company from whom he purchases. Makeshift or obsolete ideas may have been permissible in the past; today, however, the necessity for maximum production demands the adoption of the most modern means of lubrication, in the interests of continued and efficient operation.

For this reason builders of pneumatic tools have given much attention to the development

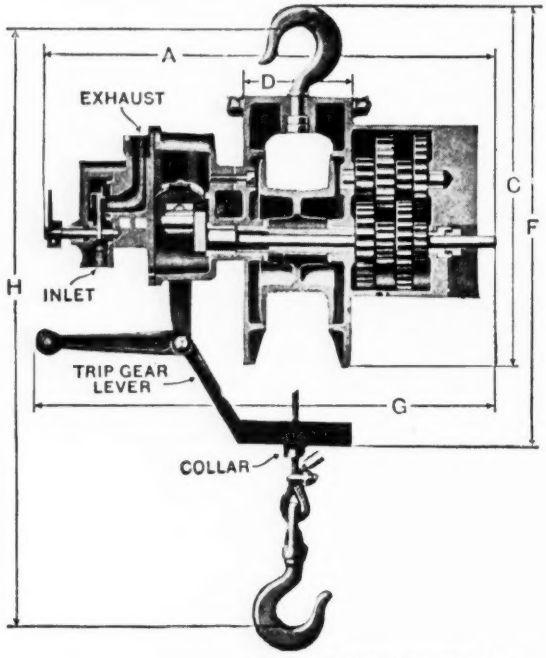
Courtesy of Hanna Engineering Works

Fig. 16—A suction type of oiler. Air in passing through exerts a suction action which charges it with sufficient oil to adequately lubricate all parts. Oil flows only when air is passing through the lubricator.

of automatic lubricators. Till today we have such excellent devices available as are shown in the accompanying illustrations. These devices may be installed either directly in the air line, a short distance back from the tool, or in some cases within the valve chest.

Air Line Lubricators

Such devices are in general intended for the handling of fluid oils. As a rule they work on the principle of atomization, pulsation,



Courtesy of Chicago Pneumatic Tool Co.

Fig. 17—A geared air hoist shown in sectional view to illustrate details of construction.

or suction action. In the latter type the air, in its passage through the working mechanisms, draws the requisite amount of oil from the reservoir by suction. Where atomization is involved, there is a needle or pin valve through which a certain amount of air passes to carry the required lubricant forward into the tool. In either case air as it passes through the lubricator becomes charged with oil in finely atomized condition, to insure effective distribution to all parts of the tool with which it may come in contact.

Pulsation is also employed in the lubrication of air prior to its passage to the tool. Operation of such a lubricator is brought about by the reciprocating action of the piston, oil being kept in continuous flow thereby to the air and tool mechanisms. Such a lubricator is frequently built with an oil capacity sufficient to last over a working shift. Therefore the possibility of lack of lubrication through negligence or carelessness on the part of drill or tool operators is reduced to a minimum.

Valve Chest Oilers

The valve chest lubricator operates by virtue of the pulsations of air in accordance with the movement of the tool piston within the cylinder. As a rule such a lubricator is designed for the usage of heavier oils or liquid greases. Relubrication or re-charging is brought about by the use of lubricant-carrying cartridges, through suitable plugs.

Chuck lubrication is also mechanically effected on many types of tools, a suitable device being attached near the front end adjacent to the chuck parts. In certain types of such lubricators ports are provided for carrying of the lubricant to the impact end of the piston and chuck mechanisms. Grease is usually preferred for the lubrication of such parts, a grade of medium bodied cup grease being adaptable to average operating conditions.

Conclusion

In the operation of air compressors, especially, there are certain fundamental precautions which are decidedly important. It is therefore fitting to conclude this study on the lubrication of Compressed Air Machinery by brief mention of these details, with their reasons why, viz.:

1. *Use Clean Cold Air*—to keep temperatures down and prevent dust and dirt from entering the system. If clean air is not assured, use an air cleaner or filter wherever possible.
2. *Use Cold Water*—to insure as low cylinder temperatures as possible.
3. *Use Soft Water*—to prevent scaling of cooling water jackets.
4. *Inspect Valves, etc., Periodically*—to note extent of lubrication, and whether carbon formation is occurring.
5. *Clean Air Cylinders About Once a Week*—in order to remove carbon formations. Use a soft soap (feeding same into system instead of lubricating oil for several hours.) Air lines to receiver should be thoroughly blown out after each wash.
6. *Inspect Cooling Water Jackets Periodically*—to note extent of scale formation. Also clean if necessary.
7. *Install an Aftercooler*—to cool and condense oil so that it can be properly drained from the system.
8. *Install a Receiver*—to equalize air pressures; and finally
9. *USE GOOD OIL*, and just enough of it to lubricate the air cylinders properly. Judge this by the condition of valves and cylinder walls.

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